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Research Article

Changes in Intraocular Pressure After Exercise in Newly Diagnosed Glaucoma Patients and Normal Subjects – A Pilot Study

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ABSTRACT

Glaucoma is a growing public health challenge and raised intraocular has been found to be the only modifiable risk factor. The aim of this study was to assess the effect of exercise on intraocular pressure. This was a prospective case control study in which twenty consecutive newly diagnosed primary open angle glaucoma patients (POAG) were included as cases while 20 age-matched normal subjects were controls. The intraocular pressure in both eyes at baseline and at various time intervals post exercise were measured with a Perkins hand held applanation tonometer and recorded for both cases and controls. The results were collated and analysed with the version 20 SPSS software. The intraocular pressure was observed to significantly decrease after exercise on the treadmill at various time intervals ($p<0.05$). This study suggests that exercise may reduce intraocular pressure in Nigerians. Larger studies are needed to better elucidate the effect of exercise on intraocular pressure in this population of Nigerian subjects.

Keywords: *exercise, intra-ocular pressure, glaucoma patients*

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INTRODUCTION

Glaucoma is an important cause of irreversible blindness and a growing public health challenge globally. Glaucoma is currently estimated to be the second most prevalent cause of blindness worldwide after cataract (Buhrmann et al, 2000). It is the commonest cause of irreversible blindness in Nigeria. (Kyari et al., 2009) In Sub Saharan Africa glaucoma accounts for 15% of blindness and it is the region with the highest prevalence of blindness relative to other regions of the world (Resnikoff et al, 2004).

Increased intra-ocular pressure (IOP) is a major risk factor in the development and progression of glaucoma (Mcmonnies, 2016). Intraocular pressure is the only modifiable risk factor (Coleman and Kodgebacheva 2009), therefore the various treatment modalities for glaucoma are aimed at reducing this factor. Various studies have shown that physiologic alterations have an effect on the intraocular pressure (Krejci et al, 1981). The physiologic mechanisms include blood pressure, presence of toxins, variability in hormonal levels, reduction in blood lactate level, serum osmolarity and the use of electroshock therapy (Krejci et al, 1981). Exercise and physical activity have been shown to reduce some ocular parameters such as the ocular blood flow, tonic accommodation, size of the pupil, angle of the anterior chamber and retinal activity (Hong et al, 2014).

Bench presses were shown to increase the IOP by 10mmHg (Rufer et al, 2014). Certain yoga practices such as the headstand posture also increases the IOP (Pasquale and Kang, 2009). Conversely, weight lifting causes an increase in IOP by 4mmHg from the baseline but on the completion of the exercise there is a decrease of 1mmHg (Pasquale and Kang, 2009). Different forms of exercise have been reported to reduce the intra ocular pressure in particular, bicycle exercise for 9 minutes and chest bench presses were shown to reduce the intraocular pressure, in a study of healthy subjects (McMonnies 2016). In a study conducted among healthy subjects in Germany, aerobic exercise was shown to reduce the intraocular pressure and this decrease was related with the intensity of the exercise (Rufer et al, 2014). In a related study among patients with primary open angle glaucoma (POAG) who had anti glaucoma medications instilled in their eyes just before the exercise, a further decrease in intraocular pressure was found (Natsis et al, 2009).

From literature search, there seems to be little or no study on the effect of exercise on intraocular pressure in both healthy and glaucoma patients in Nigeria. This research was designed

to assess the effect of exercise on intraocular pressure in both healthy and glaucoma patients in Nigeria.

MATERIALS AND METHODS

Study design: This was a hospital based prospective comparative study in which the intraocular pressure (IOP) of 20 newly diagnosed primary open angle glaucoma patients and 20 healthy subjects were compared after exercise.

Ethical consideration: This study was approved by the University of Ibadan/University College Hospital (UI/UCH) Ethics Committee in October 2015 and the approval was valid for a year. All participants signed an informed consent form before commencement of the study. Participation was completely voluntary and unwillingness to participate did not affect the quality of care provided to the patient. The study did not pose any risk or harm to the participants.

Study location: The study was carried out at the Eye Clinic of the University College Hospital, Ibadan where patients were recruited and then taken to the gymnasium of the Physiotherapy department for exercise. The physiotherapy clinic is equipped with treadmills and other physical exercise equipment.

Participants: Only respondents within the ages of 30-65 years were included in the study. All participants were Nigerians.

Twenty newly diagnosed (within 1 year) patients with primary open angle glaucoma were recruited from the Glaucoma clinic (Ophthalmology outpatient clinic) at the University College Hospital, Ibadan. Twenty controls (non-glaucomatous patients) were recruited from healthy non glaucomatous hospital workers. They were administered with a questionnaire which contained sociodemographic questions (name, hospital number, age, gender, date of diagnosis, names of current medication, type of lifestyle, caffeine consumption).

High caffeine consumption was defined as taking at least one medium mug of coffee per day while low caffeine consumption was defined as 0-1 mug of coffee per week. Exclusion criteria were hypertensive patients, patients with cardiac disease or patients who did not give their consent to participate in the study.

Data collection: All consented patients were taken to the gymnasium, where the baseline intraocular pressure of both eyes was measured with the Perkins hand held applanation tonometer. Local anesthesia (tetracaine eye drops) was applied in both eyes and the ocular surface was stained with fluorescein strips. All cases and controls had their baseline intraocular pressure measured before the commencement of the physical exercise.

The participants jogged on the treadmill which was inclined at 10 degrees at a rate of 2.0 miles/hour for 7 minutes, after which the intraocular pressure was measured immediately (within one minute) at 5 minutes, 10 minutes, 30 minutes and 60 minutes after completion of the exercise task.

Data analysis: Data was collated and analyzed using the IBM Statistical Package for the Social Sciences (SPSS) software version 23. (SPSS Inc., Chicago, IL) Frequencies and means were generated to observe patterns of variable distribution. Repeated measures ANOVA was used to compare change in IOP following exercise. $P<0.05$ was statistically significant.

RESULTS

Twenty patients with POAG with a mean age of 49.4 ± 8.4 years and 20 healthy volunteers (control) with a mean age of 43.8 ± 10.1 years were studied. The mean age of all respondents was 46.58±9.59. Majority of the participants were aged 40-49 years. Majority of the participants lived a sedentary lifestyle and had low caffeine consumption. Table 1 shows the socio-demographic characteristics of both cases and controls

Table 1:
Socio demographic characteristics of the participants

Factors	Combined data	Cases	Control
Age of Respondents	**(%)**	**(%)**	**(%)**
20-29	1(2.5)	0	1(5.0)
30-39	8(20.0)	2(10.0)	6(30.0)
40-49	15(37.5)	8(40.0)	7(35.0)
50-59	12(30.0)	7(35.0)	5(25.0)
≥60	4(10.0)	3(15.0)	1(5.0)
Sex			
Male	25(62.5%)	14(70%)	11(55%)
Female	15(37.5%)	6(30%)	9(45%)
Type of lifestyle			
Active	3(7.7%)	0	3(15.8%)
Moderate	6(15.4%)	1(5%)	5(26.3%)
Sedentary	30(76.9%)	19(95%)	11(57.9%)
Caffeine consumption			
High	1(2.5%)	0	1(5%)
Moderate	4(10%)	1(5%)	3(15%)
Low	35(87.5%)	19(95%)	16(80%)

Table 2 shows the mean IOP between cases and control subjects at different time periods. The mean IOP among the newly diagnosed POAG patients at baseline was 18.0 ± 5.7 mmHg for the right eye and 18.4 ± 6 mmHg for the left eye. There was a reduction immediately after the physical activity to 16.2 ± 4.9 mmHg (right eye) and this was statistically significant (<0.01). In the left eye the mean IOP reduced to 16.3 ± 4.9 mmHg (left eye) from baseline and this was also statistically significant ($P<0.01$, CI 1.1-3.2). While for the control subjects, the mean IOP at baseline was 14.8 ± 1.6 mmHg (right eye) which reduced to 12.6±1.6mmHg immediately after exercise and this decrease was statistically significant ($P<0.01$, CI=1.5-2.8). In the left eyes the mean IOP was 15.1 ± 2.5 mmHg (left eye) at baseline and this reduced to 13.0± 2.1 mmHg ($P<0.01$) immediately after the treadmill exercise. Table 3 compares the mean IOP at baseline and 60-minute post exercise among cases. Table 4 shows the comparison of mean IOP at various time intervals after exercise between sexes.

Table 2:
Comparison of mean IOP between cases and control subjects

	Right Eye				Left Eye			
	Cases	**Control**	**t**	**P value**	**Cases**	**Control**	**t**	**P value**
Baseline	18.0± 5.7	14.8 ± 1.6	2.4	0.02	18.4 ± 6.0	15.1± 2.5	2.3	0.03
immediate	16.2± 4.9	12.6 ± 1.6	3.1	0.005	16.3 ± 4.9	13.0 ± 2.1	2.8	0.01
5 mins after	15.6 ± 4.6	12.7 ± 2.1	2.8	0.01	16.8 ± 5.4	13.4 ± 2.1	2.6	0.02
10 mins after	16.3 ± 4.9	12.8 ± 1.9	3.0	0.006	16.5 ± 5.6	13.3 ± 1.8	2.4	0.03
30 mins after	16.1 ± 4.7	12.3 ± 1.7	3.4	0.002	16.8 ± 5.3	13.0 ± 2.2	2.9	0.007
60 mins after	16.6 ± 4.7	12.9 ± 1.8	3.2	0.004	17.3 ± 5.4	13.0 ± 2.1	3.1	0.005

Table 3
Comparison of mean IOP at baseline and 60 minutes' post exercise

	Right Eyes			Left Eye		
	Cases	**t**	**P value**	**Cases**	**t**	**P value**
Baseline	18.0± 5.7			18.4 ± 6.1		
60 min after	16.6 ± 4.7	3.1	0.005	17.3 ± 5.4	3.3	0.004

Table 4
Comparison of mean IOP at various time intervals after exercise between sexes

	Right Eyes							
	Cases				**Control**			
Study-time	**male**	**female**	**t**	**p**	**male**	**female**	**t**	**p**
Baseline	18.3± 5.6	17.3±6.5	0.3	0.7	14.8±1.7	14.7±1.6	0.2	0.8
Immediately	16.2±4.7	16.2±5.8	0.02	1.0	12.5±1.7	12.8±1.6	-0.5	0.7
5 mins after	15.4±4.2	16.8±5.7	-0.6	0.5	13.1±2.3	12.2±1.9	0.9	0.4
10 mins after	16.1±4.3	16.7±6.5	-0.2	0.8	13.1±2.0	12.3±1.7	0.9	0.4
30 mins after	16.1±4.4	16.2±5.7	0.01	1.0	12.5±2.0	11.9±1.4	0.9	0.4
60 mins after	16.4±4.4	17.1±5.9	-0.3	0.8	13±2.0	12.7±1.6	0.4	0.7
	Left Eyes							
Baseline	18.2±6.0	18.8±6.5	-0.2	0.8	15.1±3.1	15±1.7	0.08	0.9
Immediately	15.9±4.9	17.2±5.2	-0.5	0.6	12.7±2.5	13.2±1.6	-0.5	0.6
5 mins after	16.6±5.5	17.2±5.4	-0.2	0.8	14±2.2	12.7±1.8	1.5	0.2
10 mins after	16.5±5.6	16.7±6.2	0.07	0.9	13.5±2	13±1.6	0.7	0.5
30 mins after	16.8±5.1	16.8±6.1	0.02	1.0	13.3±2.5	12.6±1.8	0.7	0.5
60 mins after	16.8±5.4	18.4±5.8	-0.5	0.6	13.2±2.5	12.8±1.6	0.4	0.7

DISCUSSION

This study demonstrated that there was a decrease in intraocular pressure after being subjected to exercise and this was statistically significant. From the mean IOP observed there was a fluctuating decrease in intraocular pressure within the first minute and 30 minutes, but after 30 minutes the IOP started rising but did not return to the baseline level within the first hour after the exercise Similar studies have been conducted on this topic and similar results were produced (Hong et al, 2014 and Natsis et al, 2009). Our results were consistent in all eyes except in the left eyes of female glaucoma patients where the IOP returned to baseline at one hour probably due to variability in the measurement of IOP.
Several studies have reported that exercise reduces IOP (Conte et al, 2009, Price et al, 2003 and Qureshi 1996). This decrease however is more pronounced in patients with higher IOPs at baseline (Guyton, 1991). Although exercise reduces IOP, this reduction is reversible and returns to baseline value early after stopping the exercise (Esfahani et al, 2017). It has been reported that aerobic exercises for 3-6 months can result in reduction in IOP in patients with glaucoma. However, this returns to baseline level after 3-5 weeks of quitting exercise (Buckingham et al, 1986 and Passo et al 1987). It is therefore important to encourage glaucoma patients to engage in regular exercise.

During exercise, there is stimulation of the sympathetic nervous system with production and secretion of large quantities of adrenaline and noradrenaline. These substances reduce the outflow resistance at the trabecular meshwork and also reduce the rate of aqueous production (Esfahani et al, 2017). Progressive exercise also increase ocular perfusion pressure thereby increasing the amount of blood to the optic nerve head. Vasoconstriction occurs as a response to increase in perfusion pressure which normalizes flow and leads to faster capillary and overall retinal blood transit (Harris et al, 1996). Therefore, in addition to reduction in blood pressure, exercise also increases the ocular perfusion pressure.

This study showed that exercise reduced intraocular pressure in healthy Nigerian subjects and in patients with glaucoma.

There were some limitations in this study. This includes the small number of the participants involved which may have been responsible for a return of IOP to baseline after exercise only in the left eyes of female glaucoma patients. This may also have been due to variability in intraocular pressure measurement. In order to make a generalizable statement or conclusion, a larger sample size needs to be studied. Also the intervention time (time for exercise) may need to be longer. A future study which would involve a longer length of exercise is recommended.

Based on the result of our study, we suggest that exercise may be used as an adjunct in the management and control of intraocular pressure in patients with primary open angle glaucoma. Larger studies are needed to conclusively elucidate the role of exercise in the management of primary open angle glaucoma in Nigerians

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